This invention may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein. Rather, the embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the concept of the invention to those skilled in the art. In the drawings, the thickness of a layer or region are exaggerated for clarity. It will also be understood that when a layer is referred to as being "on " another layer or substrate, it can be directly on the other layer or substrate, or intervening layers may also be present.

[0155] Fig. 1 is a view showing an apparatus for numerically analyzing a growth degree of grains on a surface of a semiconductor wafer in accordance with an embodiment of the present invention. The apparatus can be a scanning electron microscope (SEM) with a built-in computer.

[0160] Generally, the SEM has an electron gun for producing electrons, electron lens units, a chamber unit, and display units. The electron lens units include a first condenser lens 16, a second condenser lens 18 and a scanning coil 20. The electron lens units 16, 18 and 20 accumulate and irradiate the electrons produced by the electron gun 12 toward a surface of a specimen 30 to thereby control a magnification of an image. The chamber unit includes a stage 28 for loading the specimen 30 thereon, a backscattered electron detector 22 for detecting backscattered electrons 24, and a secondary electron detector 32 for detecting secondary electrons 26. The stage 28 may be tilted at an angle θ as described later. The display units include an image processor 34, e.g., a scanner, for processing electrical image signals generated by the detectors 22 and 32, and a monitor 38 for displaying the processed image signals on a screen thereof.

[0165] Additionally, the SEM further comprises a computer 36 for processing

required data and controlling the operation of the SEM, and an analog-to-digital converter 37 for converting an analog signal outputted from the secondary electron detector 32 into a digital signal and providing the digital signal to the computer 36. The SEM is a microscope for forming an image using the secondary electrons 26 and the backscattered electrons 24, which are sputtered when electron beams 14 are irradiated on the surface of the specimen 30, to thereby observe a surface state of the specimen 30.

[0170] Fig. 2 is a cross-sectional view showing a predetermined portion 54 of an OCS-type capacitor cell 50 in which hemispherical grains (HSGs) are grown on the specimen 30, i.e., a semiconductor wafer.

[0175] Initially, in order to perform the method of the present invention, one must scan the surface of the semiconductor wafer, especially that of the capacitor cell 50 to thereby obtain an image data thereof. The scanning procedure is described in greater detail below.

[0180] First, if a recipe for an SEM scanning operation is selected, the specimen 30, i.e., the semiconductor wafer, is loaded on the stage 28, and a specific portion to be tested is searched. The optimum magnification and focus are determined while tilting the stage 28, and then, the image is scanned and stored. Unlike a stack-type capacitor, since the surface area of an upper distal portion of the OCS-type capacitor cell 50 is small, it is difficult to accurately determine the growth state of the HSGs only using the image of the upper distal portion. For this reason, it is necessary to obtain a sidewall image of the capacitor cell 50 in which a majority of the HSGs 52 are grown. Therefore, it is preferable that the electron beams 14 should be uniformly incident on the upper portion and the sidewalls of the capacitor cell 50 by tilting the stage 28 to a predetermined angle (θ), e.g., about a 45 degree angle.

[0185] The electron beams 14 are produced by applying a high voltage to the electron gun 12. The electrons 'e' emitted from the electron gun 12 are accelerated and concentrated within the electron lens units 16, 18 and 20 due to an acceleration voltage and are then irradiated toward the specimen 30. When the electron beams 14 are irradiated toward the specimen 30, electrons 'e', such as the secondary electrons 26 and the backscattered electrons 24, having various information are emitted. The detectors 22 and 32 detect the backscattered electrons 24 and the secondary electrons 26, respectively, and the detected electrons are converted into an electrical signal. Then, the electrical signal is amplified to thereby generate an analog image signal.

[0190] Since the SEM image obtained from the secondary electrons has a deep depth of focus, the SEM image is clear even though the specimen has a rough surface such as a cut section. The image data is transmitted to the monitor 38 through the image processor 34, and the surface image of the specimen 30 is displayed or provided as a photograph by a camera (not shown). Moreover, the image signal is converted into digital data by the analog-to-digital converter 37, and the digital data is stored in the computer 36 in a form of an image file. The image file is linked to the information on a test position and an identification number of a test slot.

[0195] Alternatively, rather than storing the backscattered electrons as the image file, the SEM perceives the raw data itself of the backscattered electrons as the electrical signal and stores the data into a memory. The stored data is used as basic data. At this time, it is more useful to perform the above-mentioned process using the image data in the SEM in order to improve an interface with an operator of the equipment.